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CLIMATE, IRRIGATION, AND EARLY MAN IN THE HADHRAMAUT

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000 IN a land as little known as South-west Arabia there is danger to the scientific traveller of getting lost. Not lost in the geographical sense, though at times that might be easy in the unending monotony of its valley floors and desert plateaux, but lost in the intricacies of a myriad detailed observations concerning them and the parts they played thousands of years ago in the lives of their inhabitants. The traveller crawls about like an ant amongst the dust heaps, collecting facts; facts related and unrelated, important and unimportant, which eventually, perhaps years hence and in other hands, go to the making of an ever-incomplete picture. He may be envious of the all-embracing synthetic view, such as the airman may obtain; but he remains aware that his microscopic, analytic rummaging amongst the individual stones is the indispensable element in eventual comprehension of the whole. Such reflections are not an inappropriate preface to this paper, which is the record of hitherto unrecorded facts. That the unimportant may not have been winnowed yet from the important is recognized: it is too soon to be sure which is which, or what may be the wider relevance of any of them.

114 The archaeological and geological work in the Hadhramaut now to be
122 outlined, pending a detailed publication of the whole, took place during the winter of 1937–38, between November and early March. It was made possible as much by a generous grant from Lord Wakefield, with the support of this Society, as by the facilities of entry into the country given by the Aden and Mukalla administration, and not least by the Arab potentates in Qu'aiti and Kathiri territory, whose proverbial hospitality we were privileged to experience. The party consisted of Freya Stark, already a well-known and observant traveller in the country; Elinor Gardner,[1] who has contributed the major part of this paper; and myself.

1114 Scientifically the land, though beginning to be well known in its main topo-
121 graphical features, has escaped intensive study to a degree now rare, and therefore it offered a number of attractive pioneer problems to geologist and archaeologist alike. On the archaeological side the ground, in common with all Arabia Felix, was virtually *terra incognita*. Not a single date before the Christian era was fixed; almost anything might turn up. A prearranged plan of research in view of the uncertainties of the field was impossible. Nevertheless objectives have to be clarified, and mine were broadly threefold. First, to bridge the gap in palaeolithic distribution maps between East Africa and Asia. Secondly to test it as an area of possible contact with the Makran coast, Mesopotamia, and India in the third and fourth millennia. Thirdly to investigate the material culture of its pre-Islamic inhabitants, and by its

[1] My contribution is confined to the archaeological sections and to the form and general supervision of this paper in Miss Gardner's absence.

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help to introduce for the first time dating, absolute or relative, into the early history, independently of, or in conjunction with, inscriptions. Interwoven with these purely archaeological questions was Miss Gardner's geological investigation of the Quaternary physiography of the region; more especially inquiry into problems of past climates; and comparisons of Pleistocene conditions in South-west Arabia in lat. 15° N. with those of a typical desert area as studied by her in Kharga Oasis and elsewhere in the Libyan desert 10° farther north.[1] A recent Egyptian expedition under Dr. S. A. Huzayyin had done valuable work on these lines in 1936 in the Yemen, where a series of prehistoric pluvial periods had been traced, besides the possibility of a minor

one in historic times. That expedition paid also a flying visit to the Hadhramaut, but little work was done there.[2]

The general physical features of the country are well known from the excellent map published by von Wissmann in 1932,[3] and from the air reconnaissance of Squadron-Leader Cochrane [4] and the late Flight-Lieut. A. R. M. Rickards, whose map shows well the peculiar drainage system (Plate 1). Very recently a methodical aerial survey of the whole Protectorate has been accomplished, and we are privileged here to publish some of the photographs. Mr. and Mrs. Ingrams still remain the only Europeans who have travelled from

[1] *Geol. Mag.*, vol. lxix, September 1932, "Some problems of the Pleistocene hydrography of Kharga Oasis."

[2] S. A. Huzayyin, "Egyptian University Scientific Expedition to south-west Arabia," *Nature* 140 (1937) 513-4.

[3] Folder to 'Hadramaut: some of its mysteries unveiled,' by D. Van der Meulen and H. von Wissmann. Leiden, 1932.

[4] "An air reconnaissance of the Hadhramaut" (*Geogr. J.* 77 (1931) 209-16).

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114 end to end of the Wadi Hadhramaut, and accounts of their journeys have been given to the Society.[1]

The geological work

133 The geology of the coastal region around Mukalla has been described by Mr. O. H. Little, of the Egyptian Geological Survey, and those interested in the solid geology are referred to his paper.[2] This region is the most diversified both structurally and petrologically. The fundamental granite appears here overlaid by limestones of Cretaceous and Tertiary age, and faults and folds are conspicuous even from the air. The few days at Mukalla were spent in a rapid examination of the more recent geological features.

To the visitor by sea the most striking is the glistening bank of white dune-sand west of the town, probably masking a raised beach. The coast eastwards to Shihr is fringed with the remnants of a low-lying raised beach now being eroded. In the wadi immediately west of Mukalla a raised beach was noted at RL 15 m. about 1·5 km. from the shore. It consisted of semi-angular and partly rounded pebbles of granite and limestone with marine fossils. Four metres higher a second level of cellular sandstone may be either beach or river terrace.[3]

[487] After the Shihr road has passed through the coastal barrier backing Mukalla, it runs for 2 km. over an extensive gravel plain which slopes smoothly and evenly from RL 66 to RL 38 m. It then climbs a prominent ridge at RL 52·5 m., with a typical gravel profile, and descends again to a similar gravel plain. This plain is the most important erosional feature of the district: its age could not be determined exactly, but that it is Pleistocene seems fairly certain from the occurrence of palaeolithic flake implements of chert[4] on a narrow gravel ridge which rises from it near the fork of the Du'an road. This ridge lies 4 m. above the plain, and seems to be the last remnant of a more extensive level that has been destroyed by the lateral erosion of the two neighbouring wadis. These wadis bound the main plain north and south, and good gravel sections were examined in their banks, without however the discovery of flint implements *in situ* in them.

A line of levels was run from the Shihr road S.S.E. across the gravel plain towards the sea. The sketch-map and section, Fig. 1, show the principal results. The big erosional plain falls in this direction from RL 38 to RL 27 m. in 1100 m. It is then cut by the westerly wadi whose floor lies at RL 13 m. On the far side two terraces, one at RL 16 m. and a more extensive one at RL 20 m., are crossed before the gravel plain is regained at RL 22. From there it stretches for 500 m. or so seaward, and ends in a scarp feature at RL 19. It overlooks a marine terrace crowded with recent shells. Upstream these become scarcer and eventually die out, and the levels show that it is

113 [1] "A journey to the Sei'ar country and through the Wadi Maseila" (*Geogr. J.* 88 (1936) 524–51); "The Hadhramaut: present and future" (*Geogr. J.* 92 (1938) 289–312). See also *Journal R. Central Asian Society*, July 1936.

[2] O. H. Little, "The geography and geology of Mahalla" (Geological Survey of Egypt, Cairo, 1925).

[3] Near Jibuti, which we visited on the way home *via* Hodeidah, Jeddah, and Yenbo, raised coral beaches have been recorded at RL 18 and 25 m.

[4] These resemble typologically the flakes called Levalloisian in N.W. Europe.

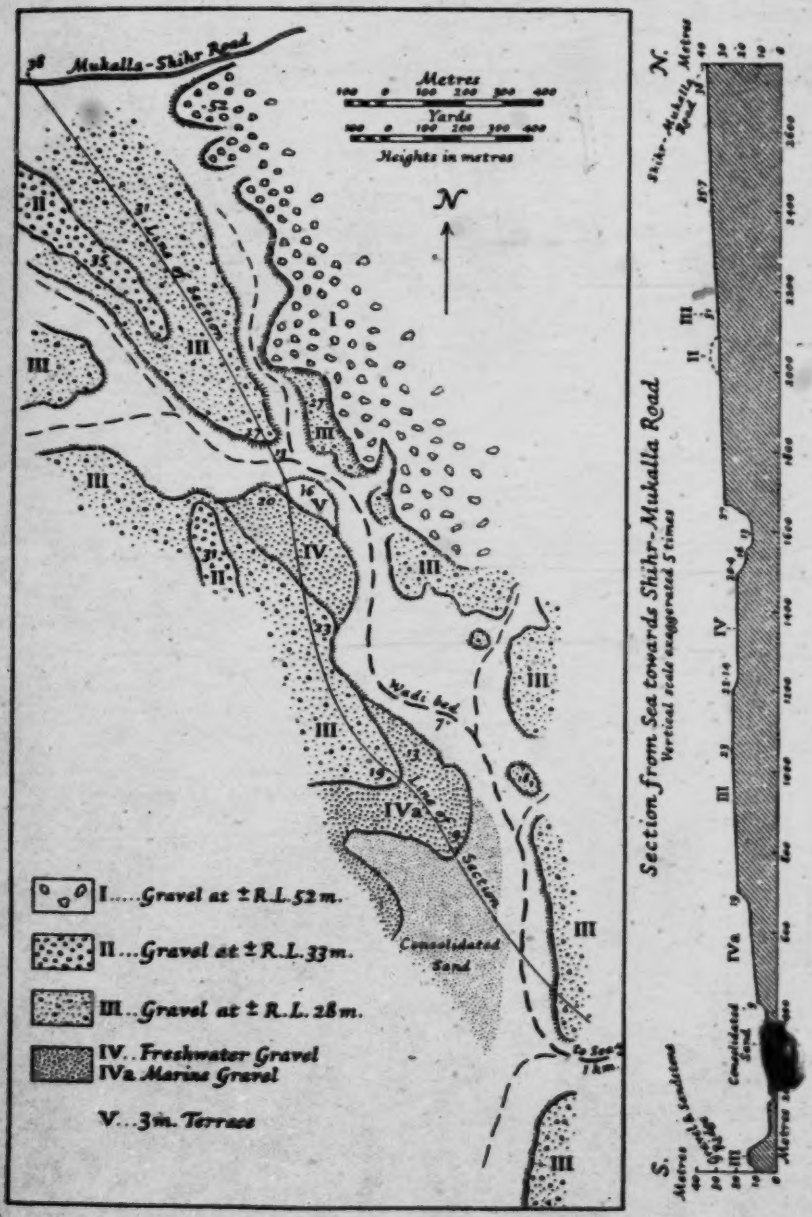
Mukalla-Shihr Road
Metres
Yards
Heights in metres
N
Line of Section
Wadi bed
Consolidated Sand
I.....Gravel at ± R.L. 52 m.
II...Gravel at ± R.L. 33 m.
III...Gravel at ± R.L. 28 m.
IV. Freshwater Gravel
IVa Marine Gravel
V...3m. Terrace
Section from Sea towards Shihr-Mukalla Road
Vertical scale exaggerated 5 times
Shihr-Mukalla Road
Consolidated Sand
Metres

Fig. 1

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the seaward end of the 16 m. terrace already mentioned. It slopes from about RL 15 beneath the higher plain to RL 12. Here it ends in a scarp about 2 m. high, and below it a consolidated yellow sand forms the wadi floor. The channel here turns and breaks through a ridge to the sea. This ridge is composed of cellular sandstone similar in appearance to that seen near Mukalla and, in some places, of gravels. From its level it would seem to be the last remnant of the big erosional plain on the east side of the wadi.

We have then in this area three well-defined levels and a minor one. These in order of age are: high-level gravel, RL 52 m., possibly Tertiary or early Pleistocene; remnant of erosional level, about RL 32 m., with palaeolithic chert implements on surface; extensive and important erosional plain, about RL 28 m., no sign of marine deposits passing downstream; terrace at 7 m.–5 m. above wadi floor at RL 16 m.; and a terrace at 3 m. above wadi floor.

The road to Shihr continues along the coastal plain, crossing marine beds in many places, and runs over an extensive development of gravel just before reaching the town.

The coastal plain is here some 10–12 km. broad, and is backed by the great cliffs and outliers of the South Arabian plateau, called the *jol*. It is some 1000 m. high, but slopes gradually northwards up to 3000 m., becoming ever more barren as it recedes from the influence of the monsoon rains. The newly made road to Tarim follows a switch-back course over it, now crossing stony plateaux, then descending into broad flat-bottomed wadis often sand-covered and with lines of trees and scrub marking the watercourses. In these wadis a loess-like deposit that was later to become such a familiar and prehistorically important feature in the Wadi Hadhramaut and its tributaries, was first seen. Here, as there, it seems to have filled the valleys through which later erosion has carved a way. Near the village of Reida, in the Ma'ara country about 60 km. from the southern edge of the plateau, rounded consolidated gravel and conglomerate were seen near a water-hole.

The watershed between the north and south-running valleys lies much nearer the southern than the northern edge of the plateau; this is possibly due to subsidence of the coastal area, and as a consequence many of the wadis draining into the Wadi Hadhramaut are very long. Nearing the edge of this great wadi the character of the drainage changes; instead of broad flat-bottomed valleys, there are narrow ravines deeply entrenched in the limestone (Plate 4). On the stony ground between them numerous deeply patinated palaeoliths, both cores and flakes, were found, similar in type to others whose occurrence *in situ* in gravel terraces of the valley floor system will be described later. Their position here, on tongues of plateau furrowed by deep ravines, recalled the occurrence of typologically similar implements on similar tongues of plateau licking the cliff edge of the Nile valley.

We first saw the Wadi Hadhramaut from the top of the pass leading sharply down to Tarim. It is a great flat-floored trench some 3 km. broad and 300 m. deep, bounded by high cliffs of characteristic outline, which repeats itself with monotonous regularity both along the main wadi and in the tributary valleys. This outline is the expression of the geological features, which are here very simple (Plates 2, 3). The cliffs consist of a series of almost horizontal beds; the upper 200 m. are of limestone, Eocene over Cretaceous.

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1. The Hadhramaut: entrenched drainage and characteristic denudation

Facing P. 22 (A)

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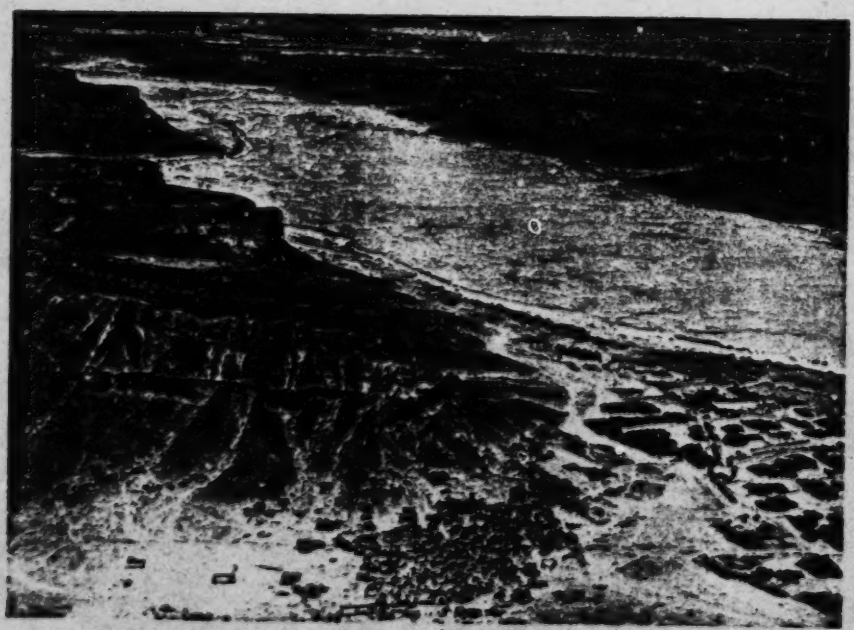
2. Wadi Hadhramaut at Seiyun, looking down the valley



3. Wadi 'Amd at Hureidha

Facing P. 22 (B)

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133 The Cretaceous bed is particularly massive and juts out beyond the overlying strata to form bold headlands between the lateral wadis. The more gentle slope below to the wadi floor is due to soft red sandstones, with occasional shaly layers towards the top. They are probably the local representatives of the Nubian sandstone. Owing to their softness they are being eroded rapidly and consequent undercutting of the superposed limestone causes huge falls of rock. The result is a thick mantle of scree, consolidated in places to a breccia which almost hides the sandstones. The formation of this scree must have begun far back in the wadi's history, for not only have the talus slopes been cut into "semi-detached" hillocks, but they appear to plunge under the valley filling. Numbers of chert implements of Levallois type lie in and on the scree and argue a *status quo* as far back as the middle [172] or later Pleistocene. In historic times also these screes and breccias were put to practical use, for tomb entrances of the pre-Islamic inhabitants of these valleys were cut through them, and sepulchral caves hollowed out in the soft sandstone slopes beneath.

Travelling along the main wadi and up its tributaries, the beds in the bounding cliffs appear to remain at a constant level above the wadi floor. The strata cannot therefore be truly horizontal, but must rise gradually both west and south. To one used to the valley systems of Egypt a striking feature of the Wadi Hadhramaut is the monotonous flatness and uniformity of its floor (Plate 3). No great prehistoric gravel terraces mark higher water-levels, and the present flood-channel or "*seil*-bed" is a relatively insignificant feature. Obviously the most important episode in the wadi's history, after its actual cutting, was the deposition of material which filled it and its tributaries to some unplumbed depth. The upper part of this fill is a fine sandy silt, which will be described later, but there is reason to believe that gravels underlie it, for farther down the main wadi they come to light. Moreover in the Wadi 'Adim, an important tributary coming in from the south near Tarim, the 15-m. section of the wadi bank shows 4–8 m. of silt overlying thick gravel bands (Plate 5). These gravels fade out before the mouth of the wadi is reached, and have presumably plunged deeply down and may join similar deposits in the main valley.

The Wadi Hadhramaut shows a curious reversal of the normal valley form in being wider towards the source than the mouth. In the narrower stretch below Tarim, known as the Wadi Maseila, Mr. and Mrs. Ingrams found lava-flows which, it has been suggested, may once have blocked the course. Air photographs show the position of this lava, but have not conclusively corroborated the idea. The narrowing, moreover, begins before this point for no apparent petrological reason, and the cause more probably lies in the wadi's history, and is conceivably due to complicated river capture. Unfortunately time and tribal conditions prevented an examination of this area.

[361] All the detailed work of the expedition was done from the small town of Hureidha in the Wadi 'Amd, 24 km. from its junction with the Wadi Hadhramaut. Here one of the most important tributary systems enters from the south. It consists of two big valleys which divide, 10 km. from their common outlet, into the Wadi Du'an running due south for 80 km., and the Wadi 'Amd running south-south-west for over 120 km. Near the junction of the

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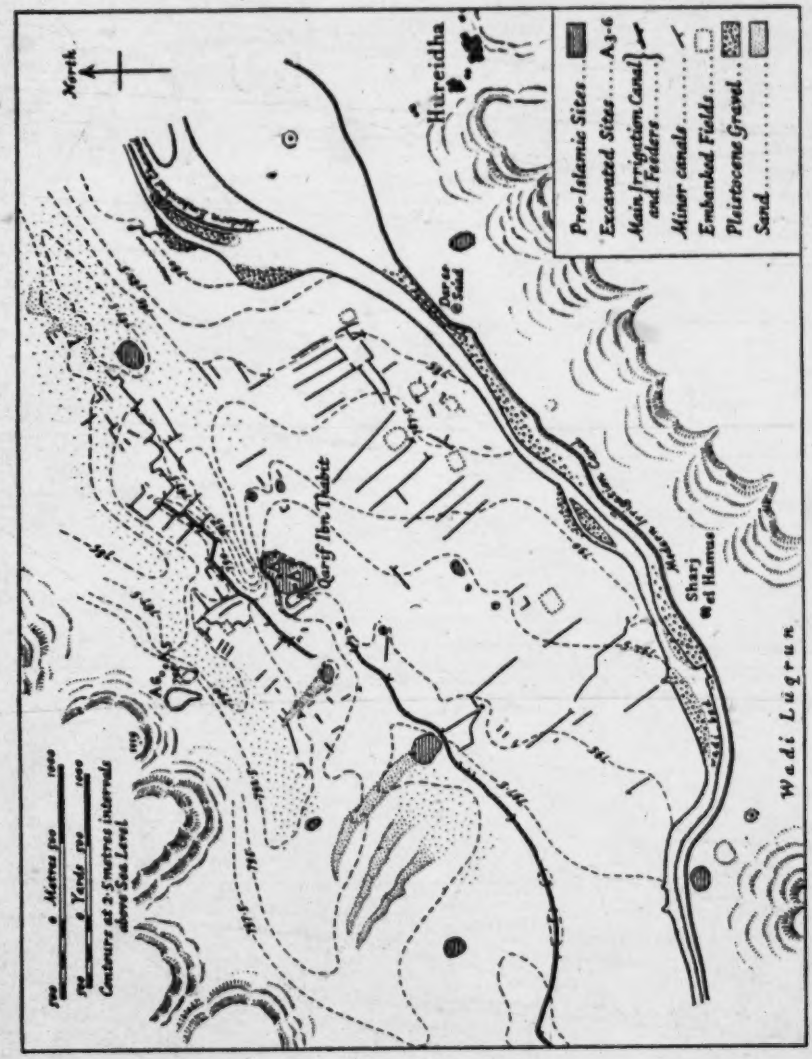

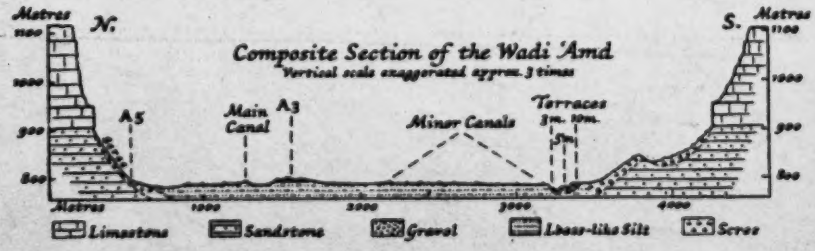

Fig. 2 p. 24

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two great wadis the silty deposit, which we propose to name "aeolian silt," has been eroded into hillocks reminiscent of those on the floor of Kharga Oasis, except that they are larger and not so stream-lined by wind. The subordinance of wind erosion in the Hadhramaut is in striking contrast to conditions in Kharga, and emphasizes the difference between a true desert-belt and one under the influence, however incompletely, of the monsoons.

The work around Hureidha consisted of the examination of the geologically recent deposits, and the detailed mapping of a small area around the ruin field (Fig. 2). The section, Fig. 2, shows that the structure of the valley is the same as that in the Wadi Hadhramaut.

The valley filling is the dominant deposit. It is on the whole a fine-grained material, largely arenaceous but with a certain amount of clay. Structurally it shows the prominent vertical jointing so characteristic of loess and aeolian deposits in general. Yet this is not the only guide to its origin, for clay bands and occasional scattered lines of pebbles point also to water action. It seems therefore convenient to use the term "aeolian silt" for this deposit to represent its composite character, part wind, part water-laid. Water action would seem to have played a greater rôle here than in Kharga, where wind bedding, absent in the Hadhramaut, is common. A good section was examined in the banks of the flood channel north of Hureidha (Plate 6). Two darker banks can be seen running nearly horizontally 1 and 2 m. from the top of the section. These are formed of more argillaceous material, and clay balls were common in the sandy layers. Here and there a pocket of land shells lying at all angles was found. These were mostly *Zootecus insularis* Ehrn, but a few *Obeliscella bentiae* M. and P. and *Pupoides* sp. also occurred. The full depth of the filling could nowhere be ascertained. The wells in the floor of the Wadi Hadhramaut are shallow, and in the Wadi 'Amd, though very deep,[1] they are in the rising sides of the valley. In discussing the age of the aeolian silt we can therefore speak only of the upper layers.

In the Wadi 'Amd good dating evidence was obtained in the north bank of the flood channel opposite the Wadi Luqrun, a tributary wadi entering from the south near the village of Sharj el Hamus (see Fig. 2). Here a magnificent section is exposed in a cliff 10–8 m. high (Plate 7). It is capped by four or more metres of aeolian silt which stretches away northwards and forms the whole floor of Wadi 'Amd. This is underlaid by two gravel bands separated by more aeolian silt, which in turn underlies the lowest gravel and forms the floor of the flood channel. The gravel bands are about 1·5 m. thick, and consist of medium to small limestone pebbles with occasional ones of chert or tufa. Both bands contain chert implements but they are particularly abundant in the lower. In the sides of the erosion channels the gravels are seen to tail out northwards and eventually disappear. They obviously represent the outwash fans of the Wadi Luqrun, which seems to have been capable of carrying gravels while the main wadi was bringing down silt only. The tools in these gravels are of Levalloisian flake type, and date the uppermost layers of silt in the Wadi 'Amd. Confirmation was obtained by finding a good unworn tortoise core embedded in the silt at another spot.

[1] Van der Meulen and von Wissmann state (*op. cit.*, p. 98) that some are about 300 feet deep.

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134 A more active phase succeeded the silt filling of the valley. On its southern edge floods again brought down gravels, but this time down the main wadi itself. These occur in three terraces at 10 to 8, 5, and 3 m. respectively above the thalweg (Plate 8). All contain implements of the same type as those found in the section already described, but they are most numerous in the 10-m. terrace. The gravel is composed of similar elements in all, the only distinction being that in the 5 and 3-m. terraces true current-bedded sands occur which appear to be absent in the 10-m. terrace. The latter is interbedded in places with aeolian silt, probably derived from pre-existing deposits. All the terraces are laid against the silt and occasionally the gravel overlaps it on the north bank. It never however spreads far north, and in this stretch of the wadi the flood channel seems always to have kept more or less closely to the southern cliffs.

The 10-m. terrace is best developed between Dar es Sa'ad and Sharj el Hamus on the southern bank of the channel (see map, Fig. 2). It is frequently obscured by ancient and modern irrigation works and agricultural operations. At the entrance of the Wadi Luqrun a big stone barrage has been built across the mouth of the channel to prevent backward erosion. This wall abuts against the 10-m. terrace, which stands out darker coloured in contrast with the lighter-coloured gravel of the 5-m. terrace below it. It has occasional pockets and layers of aeolian silt in it, but downstream these increase in importance till a little east of Dar es Sa'ad only 1 m. of gravel rests on solid silt. Beyond this point the 10-m. gravel is not seen, the south bank being of aeolian silt until the Hureidha lateral valley is reached, when the 5-m. and 3-m. terraces become prominent.

At this point the 5-m. terrace is laid against the silt on the south side, while on the north bank a scatter of gravel at 5 m. probably represents the remnant of this terrace. Near Dar es Sa'ad it seems to be cut out of the 10-m. gravel, and upstream from here spreads out to form a broad bay. In these sections however it is once more resting on aeolian silt. A typical exposure showed:

top 1·5 m. gravel, medium-sized pebbles, occasional patches of aeolian silt
1·5 m. gravel of finer texture with 1 cm. mud layer overlying current-bedded sands
0·5 m. coarse gravel
about 1·5 m. sand and pebbles overlying irregularly the eroded floor of aeolian silt, here forming the wadi bed.

No implements were found in this section, though a few were collected *in situ* near Dar es Sa'ad and Hureidha.

The 3-m. terrace forms low flats cut through by the modern flood channel. It may rest against the aeolian silt on the 5-m. terrace, which it resembles in all respects but level. A few rolled implements were found in it in the Hureidha section. East of Dar es Sa'ad it is well developed, and shows 1 m. of rather coarse gravel resting on aeolian silt. At this point it has been utilized for the start of the modern embankment that leads the flood waters down a recently cut canal to 'Andal.

We have so far traced a series of events which might be interpreted climatically as a dry phase (the deposition of the silt), followed by one of greater

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4. Jol above Tarim: palaeolithic area at the head of lateral wadi

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5. Wadi 'Adim: exposure of aeolian silt over gravel

Facing P. 26 (A)

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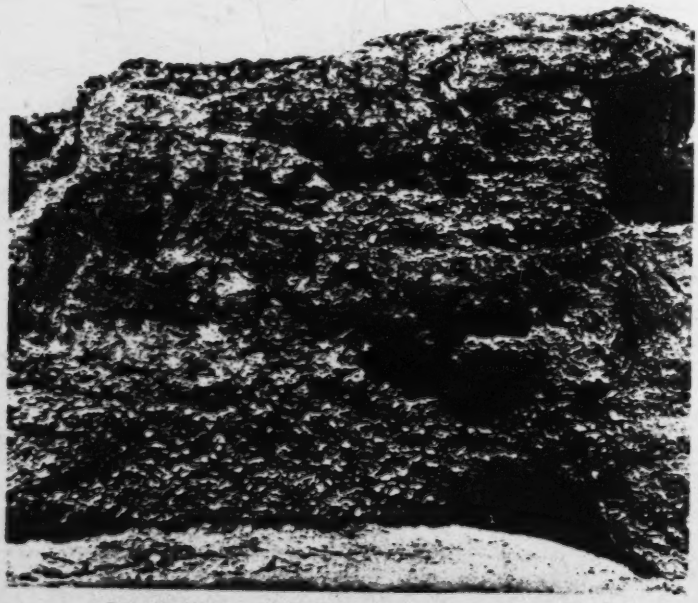
6. Aeolian silt cliff and present flood bed in Wadi ʿAmd



7. Interbedded aeolian silt and gravels in Wadi ʿAmd

facing p. 26 (B)

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rainfall, represented by the gravel terraces. But this sequence might also be due to other causes such, for instance, as the blocking of the Wadi Hadhramaut by the lava-flows, and therefore it was necessary to look for independent evidence. Von Wissmann observed that the plains of the Yemen are floored with a great layer of fine sandy soil, aeolian in origin and very similar to loess.[1] This in a neighbouring country lends support to the climatic origin of the changes. Reinforcement comes also from the occurrence of aeolian silt, already mentioned, in the wadis of the *jol* far removed from the influence of the Wadi Hadhramaut. Further support on other lines was also obtained in the Wadi 'Amd itself, during the examination of small lateral wadis.

Some of these minor lateral wadis and ravines have springs trickling from the base of the big Cretaceous cliff, and it seemed possible that if a period of greater rainfall had, as surmised, occurred in the past, evidence would be registered in the formerly more abundant flow of these springs. In Kharga Oasis few springs still exist on the scarp, but we found there conclusive proof of more abundant water in the Pleistocene. This was demonstrated by the great deposits of travertine or tufa which in places completely mask the underlying rocks. In the Hadhramaut ancient tufa was found near the existing springs, and as terraces in the ravines above them, but developed on a far smaller scale than in Kharga (Plate 9). This may be due partly to the difference in configuration, and partly to the monsoon erosion in the Hadhramaut. Its occurrence does however point to a time of greater rainfall and spring activity. But, though on a smaller scale, the Arabian tufa deposits are strikingly like those of Kharga in their general aspect. In both places they have weathered to a rusty brown-black with a light yellow fracture, and in both places massive and cellular types occur, though nothing resembling the "plateau" tufa of Kharga was found. They all belonged to the "wadi" type.[2]

The deposit in both places contains fossil leaves, amongst which fig leaves are predominant, and shells, though these are unexpectedly much more abundant in Kharga than in the Hadhramaut. Moreover in Arabia the tufas were not, in the areas examined, associated with interbedded silts and gravels, as in Kharga, nor were palaeoliths, as there, *in situ* in them. The dating of the Kharga tufas in archaeological terms is therefore much more definite and susceptible of subdivisions than in Hadhramaut; but the palaeolithic age also of the latter is placed beyond doubt by the occurrence of tufa pebbles in the 10-m. gravel terrace, and in the gravels interbedded with the aeolian silt.

A typical spring and tufa terrace outcrop in Arabia may now be described for the first time.

The modern springs issue in lateral ravines at or near the base of the massive lowest Cretaceous limestone, which is undercut sometimes by as much as 20 or 30 m. A good example was found in a small valley on the west side of the Wadi Luqrun, where two trickles of water come from cracks in the limestone about 1·5 m. above its base. A soft spongy mass of recently formed

[1] C. Rathjens and H. von Wissmann, "Vorislamische Altertümer" (*Südarabien-Reise*, Band 2, 1932, p. 14).

[2] For discussion of these tufas see Caton-Thompson and Gardner, "The prehistoric geography of Kharga Oasis" (*Geogr. J.* 80 (1932) 369–409), and Gardner, "Some problems of the Pleistocene hydrography of Kharga Oasis" (*Geol. Mag.*, vol. lxix, September 1932).

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tufa surrounds, and almost blocks, the outlet, and forms a small fan below. In one case a narrow channel has been humanly cut in the deposit to lead the water into a cement tank from which periodically a few palms are watered. The surplus water overflows and is lost in the scree. Growing amongst the huge boulders are shrubs and trees, wild figs, *Ficus salicifolia*, and *F. sycamorus* being particularly common. Around the water itself maiden-hair fern and other small plants make a pleasant green garden in the rocky desolation.

At this level there is a limestone platform or shelf some 10–11 m. wide, and on the edge of this occur the outcrops of Pleistocene tufa. In the Wadi Luqrun it is a block 5 m. thick and 3–4 m. high, which is evidently but a remnant of a much more extensive deposit, for traces were detected on the walls of the great limestone overhang. Its present size and isolation are some measure of the time that has elapsed since its formation. A few badly preserved fossil leaves were found here, but also a considerable number of small cavities which, as in Kharga, are the moulds of fruits. Most of these show no structure and are therefore unidentifiable, but Mrs. E. R. Reid, who kindly examined them, found one that was certainly a fruit of a species of *Celtis*.

A climb of 50 m. or so up the scree slope to the top of the Cretaceous limestone leads over bare rock to the upper course of the wadi. In time of spate the waters must cascade in a fall over the lip. At Luqrun traces only of tufa occurred at this upper level, but in a valley east of Hureidha a much larger outcrop was found which yielded many leaves. Here, after half an hour's ride along the wadi floor, the track climbs gradually up the stony scree slope to the top of the Cretaceous limestone. A hundred metres or so from the edge a mass of tufa occurs as a terrace remnant 15–16 m. above the limestone floor. It is 4·6 m. high and rests on limestone breccia. This outcrop was particularly rich in leaves. The commonest types closely resemble figs, but without the fruits this identification cannot be assured. Some however seem identical with the *Ficus sycamorus* leaves found in the Kharga tufas,[1] and another resembles *F. salicifolia*; as both trees are still growing nearby they probably occur as fossils. Some kind of palm is certainly present and one or two other unidentified types. The shells are scarce and not well preserved. *Melania tuberculata*, *Zootecus insularis*, and a *Planorbis* were present. More abundant is the cast of a lava very similar in appearance to that found in Kharga and considered by Dr. Zeuner to be that of a dipterous insect.

The pool at the foot of the cliff was examined. It is called "El Bahr"—the sea[2]—and is a favourite bathing-place, the Badawin climbing the cliff and diving in from a considerable height. Local tradition calls it bottomless, and a weighted tape failed to touch bottom at 19 m. It would seem to be a super pot-hole, ground out through the ages by the swirling stones and water of the seasonal cascade from higher levels. It is in the shade for most of the day, and water remains all the year. The shallows around are covered with soft

[1] Gardner, "The Pleistocene fauna and flora of Kharga Oasis" (*Quart. J. geol. Soc.*, vol. xci, December 1935.)

[2] Van der Meulen and von Wissmann in 'Hadramaut: some of its mysteries unveiled' describe this place. "After energetic scrambling over fields of stone and up slopes of rock we actually arrive at El Bahr, a deep, rocky basin, full of water, with high cavernous walls, from which, after rain, the water must fall in spray into the basin."

16: Gardner A-4 (1937-38) 1939 MM2 Hadhramaut MM2

muddy tufa still being deposited. No living thing was seen in the pool, but dead shells of *Bulinus*, probably *truncatus*, were collected from the muddy edge. They are small and distorted, probably owing to the excess of lime.

In a wadi still farther up the lateral valley, the Wadi Sam'ua, a series of pools occurs at the foot of successive steps in the ravine bed above the Cretaceous limestone. These pools were not so deep as El Bahr and had abundant life: fish, frogs, beetles were all seen, and two univalves (a *Planorbis* and a new species of *Ancylus*).[1] The wadi narrows to a steep-sided ravine in its upper reaches; yet clinging to the side above the first pool was a mass of tufa 4 m. high. Other pools, backed by tufa cliffs with suspended stalactites, lie at still higher levels. Here exploration had to stop, but enough had been seen to establish the interest of the terrace tufa in these upper reaches.

From the above account it may be deduced that the main events in the wadi's history are as follows:

Major erosional phase, when the great Wadi Hadhramaut and its main tributaries were cut. This in all probability took place in stages. From the amount of erosion and the many changes in the wadi since its development, the time of cutting must be at least as early as late Tertiary or early Pleistocene, and may well be far older. It cannot, as has been suggested, be synchronous with the Glacial Age in Europe.

Major depositional phase, also probably subdivided into minor episodes. The valleys were filled to some unknown depth with deposits. The upper part of these is aeolian silt of palaeolithic age, which is known to overlie gravel in some areas. In the lateral wadis tufa formation had begun.

Minor erosional phase, represented by the cutting of the aeolian silt and deposition of gravel in place of silt. This can be subdivided into three parts, the 10, 5, and 3-m. terraces, also of palaeolithic age. The flood channel then followed the same restricted course as now.

It is interesting to note that these three main phases were traced in Kharga Oasis; but there, the evidence being more complete and varied, and the time of study far longer, they could be subdivided and dated with more certainty than in the Hadhramaut. No sign of a historic pluvial was seen in that part of the country which we examined.

Archaeological notes

Quaternary palaeoliths have, in the foregoing pages, been noted: on the Mukalla gravel plain; on the spurs of the *jol* near the south edge overlooking the Wadi Hadhramaut above Tarim, in positions recalling their distribution on desert cliffs overlooking the Nile valley; on and in cliff screes of the Wadis Hadhramaut and 'Amd; and in the 10, 5, and 3-m. gravel terraces of the Wadi 'Amd near Hureidha, and in the somewhat earlier aeolian silt of the valley's main filling. These discoveries of palaeoliths were no novelty, for Mr. and Mrs. Ingrams had already noted them in many places,[2] but they had not, I believe, been previously found in geological deposits. Nor must our restricted

[1] All shells from the Hadhramaut have been given to the British Museum. Major Connolly is kindly identifying them and will publish the results in his forthcoming work on the shells of the Yemen collected by Dr. Scott, of the British Museum.

[2] *Geogr. J.* 92 (1938) 306.

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distribution list be taken to indicate more than the limitations of our wanderings, not those of palaeolithic man, who doubtless ranged over the whole area wherever water, game, and raw material for his tools and weapons could be found.

The technique of the implements collected, though falling well within the recognized limits of a specific palaeolithic culture—the Levalloisian—is almost uniformly crude compared with African, North Arabian, and Palestinian specimens of similar types. This may be due in part to the very bad quality of chert yielded by the local limestones; but since in other countries primitive man frequently triumphed over refractory rock, and succeeded in making from it symmetrical and serviceable implements in forms traditional to his peculiar culture, the excuse here is not wholly valid. It represents also, one may surmise, a genuinely low ebb in contemporary palaeolithic standards, indicative possibly of an over harsh and impoverished environment, but perhaps due in still greater measure to absence of contact with more progressive groups. This last postulate presupposes the separation at an early date in the Pleistocene, or before, of South-west Arabia from East Africa; for East Africa was, throughout the entire span of the palaeolithic period, in a position to provide just the technical stimulus lacking, apparently, in Southern Arabia.

In East Equatorial Africa an unbroken succession of Stone Age industries, made known in the first instance by Mr. E. J. Wayland and by Dr. L. S. B. Leakey, begin in Lower Pleistocene deposits and progress steadily through a series of vast physiographical happenings, which include rifting, uplift, vulcanicity, reversals of drainage, eustatic, and climatic changes, until the end of Upper Pleistocene times. No attempt can possibly be made without vastly more prolonged specialist work in South-west Arabia, and the accumulation of a store of comprehensive and independent data, to correlate the two areas. It is legitimate only to note that uplift, vulcanicity, eustatic, and climatic changes are all registered in the Hadhramaut (and also, as shown by Dr. Huzayyin, in the Yemen), though neither their geo-chronological relation to each other, nor to human history, can yet be ascertained.

But another line of reasoning reinforces the likelihood of the early marine separation of the two continents. Palaeolithic industries, legion in number and distressing in nomenclature,[1] are morphologically classified by prehistorians into three main culture groups, irrespective of relative age. They comprise hand-axe industries, flake industries, and blade industries.

The distribution of the first of these, the hand-axe culture group and its derivatives, includes practically all Africa—certainly all East Africa from north to south. Yet it failed, as far as the evidence goes, to reach South-west Arabia. In the Hadhramaut, though it is perhaps still too early to be conclusive, neither we nor Dr. Huzayyin's party found a single specimen; and the solitary example recorded by him in the Yemen [2] seems far more likely to have reached it from the north, where, in Palestine, Syria, and Transjordan, the type, in certain phases, is well entrenched.

A crude flake industry of Levalloisian type belonging to the second class

[1] In East Africa for instance at least ten distinct palaeolithic industries are known, with some two dozen subdivisions.

[2] *Op. cit.*

A crude flake-industry of Levalloisian type belonging to the second

mentioned above would seem alone to represent palaeolithic man in the Hadhramaut, where it was free from the development which in N.W. Europe has necessitated seven subdivisions. The earliest appearance we could trace was *in situ* near the top of the aeolian silt of the Wadi 'Amd infilling. In chronological succession follow the 10, 5, and 3-m. gravel terraces laid in a stream-bed cut in this silt. The scarce contents of the 3-m. terrace are derived from the two higher ones, which however show no variation in type *inter se*.

Eventual discovery of the palaeolithic contents of the older, deeply buried silt levels and gravels would be of great interest; but we may risk already the conclusion that the flake industry found *in situ* continued, isolated and unchanged, throughout a very long geological period, which we tapped at only one or two points. It would be rash on existing evidence to place its probable position in the Pleistocene, though it may well prove to lie in the middle: typology alone is insufficient, and archaeological stratigraphy will need first to be established in cave or man-favoured geological deposit, if such exist, and our failure to find a single fossil animal bone in the gravels rectified.

So much for the first of the archaeological objectives. The second of them —namely contacts with the chalcolithic east—drew a complete blank. I myself found, was shown by natives, or observed in the miscellaneous antiquities gathered together in Aden no single object which indicated any such early contacts with the Hadhramaut. Of later antiquities however there was no scarcity. Though the Wadi Hadhramaut itself in the stretch examined around Tarim, Seiyun, and Shibam yielded little except rock graffiti pecked in South Arabian characters, and accompanying animal engravings in restricted numbers, the major lateral wadis seem to offer better prospects to the excavator.

The fairly extensive pre-Islamic ruins at Sune in the Wadi 'Adim were visited for a few hours from Tarim, and sherds and other samples collected from the surface for comparison later with more westerly sites. Here too were lying numbers of the microlithic obsidian flakes in geometric forms—trapezoids, triangles, rectangles, and crescents, neatly retouched on their lateral edges—which Miss Stark had also collected in 1935 on the ruin-field of Gheibun near Meshhed in the Wadi Du'an, and had kindly shown to me.[1] I had then recognized their kinship with the latest microlithic obsidian industries in Kenya, and was prepared, in the absence of the necessary corroborative evidence from other archaeological factors, for a date considerably earlier—possibly in the second millennium—than anything hitherto known from the ruins of the old South Arabian kingdoms. Their occurrence also at Sune, amongst the dusty rubble heaps of the stone-built ruins, though suggestive of true contemporaneity could not, without excavations, be conclusive.[2] Any doubts there might be vanished later at Hureidha in the Wadi 'Amd, where my excavations of a pre-Islamic temple and its contemporary tombs, no part of which could be earlier than about the sixth century B.C. and which were mainly or entirely some centuries later, established beyond question the

[1] 'The southern gates of Arabia,' p. 166. Mr. and Mrs. Ingrams had also collected them there in 1934 (*Geogr. J.* 88 (1936) 524–51), but not, I think, the crucial types.

[2] Dr. Huzayyin in 1936 also collected these obsidian tools at Gheibun, and felt assured their date was that of the ruins.

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172 fact that geometric microliths, which in Europe and the Mediterranean area existed long before 3000 B.C., were still flourishing in South Arabia at this late date.

[1717] If analogy may be trusted, as I think here it may, the little trapezoids were used as arrow-tips, of a form well known in prehistoric Denmark at least six thousand years ago, and common (whether in flint, chert, chalcedony, or obsidian is immaterial) over large parts of Europe and the Mediterranean, including predynastic and dynastic Egypt, at various dates down to 2000 B.C., or in the Sudan over a thousand years later. In Mesopotamia Sir Leonard Woolley has recorded a variant of the type in the royal tomb of Mes-Kalam-Dug at Ur. Dr. Grahame Clark in drawing attention to this discovery [1] suggested the possibility that the type, being of such antiquity, was used for symbolical purposes in a royal grave only, and not in the other, contemporary, burials. Be that as it may, the little arrow-tips were noticeably associated with the burials we examined in South-west Arabia, though not to the exclusion of the other types, amongst which the rectangles are almost certainly sickle-blades.

That these obsidian implements in the Hadhramaut owe their appearance to African influence I have little doubt. In East Africa their progenitors, the third of the three great culture groups referred to above, are strongly entrenched, and range back uninterruptedly into Upper Palaeolithic times. In South Arabia on the contrary they appear to have no ancestry. Until analyses have been made it cannot be certain from whence the obsidian came, and perhaps not even then; for it is likely that the eruptive areas of South-west Arabia yield a volcanic glass indistinguishable from the East African variety. Local Badawin asserted that obsidian was to be found "in the mountains," pointing south-west from Hureidha. But how far away they meant remained an unanswered question.

Our excavations have been recorded in brief outline in *Nature* (vol. 142, 23 July 1938), and the results will eventually be fully published. They were confined to a spot in the Wadi 'Amd near Hureidha, which Miss Gardner and I reached on December 20.[2] The little town, about 850 m. above sea-level, compactly nestles, in approved Hadhramaut fashion, on the steep scree of a snout of cliff projecting at the confluence of a lateral wadi with the Wadi 'Amd (Plate 3). December 22 and 23 were given up to the absorbing task of examination of the ruin-field, skirted by von Wissmann and Van der Meulen in 1931.[3] It lay about an hour's donkey pace from the town, on the barren plain of aeolian silt filling the main valley, and proved to be a scattered and unenticing affair covering about 10 sq. km., and giving little hope of depth of deposit. Small evenly spaced stone-rubble heaps, at first sight puzzling, sprang from bare wind-swept ground. These, thanks to Miss Gardner's subsequent mapping, proved to be the vestiges of an old irrigation system; here also the outlines of ancient fields and boundaries could be traced. My decision to excavate rested on small beginnings. Across the plain, nearing the opposite cliffs, a sudden heaping up of consolidated and stationary sand-

[1] *Antiquity*, June 1935, pp. 210–15.
[2] Miss Stark was then in hospital at Aden, but rejoined us.
[3] *Op. cit.*, p. 199.

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dunes called for explanation. The sand must have been immobilized by something, we argued. With a first recruitment of six local men and four boys, soundings were made the following day, and we soon struck the foundations of a large stone building. Thus was discovered the temple of the Moon God, Sīn,[1] the first of its kind recorded in Arabia. It provided the complete ground-plan of a pagan semitic sanctuary, over fifty dedicatory inscriptions, and accessory details of baetyllic cult. The temple must have stood, unprotected and conspicuous, on a slight eminence overlooking in both directions the length of the level plain, then diligently watered and cultivated (Plate 10). Its enlargement, at two later periods, and the gradual rise in pavement levels, imply security over a very considerable length of time. No village appears to have flourished in the immediate vicinity, and the secular habitations on the plain around seem to have consisted of isolated farmsteads which lie buried beneath mounds. One such was excavated,[2] and proved, by the pottery, to be contemporary with the temple.

These discoveries went far to fulfil the third of my archaeological objectives. But the collection of more utilitarian material than a sacred edifice normally produces became urgent, and time was short. The paramount importance of common things is axiomatic in archaeology, eclipsing in value all the rarities beloved by the uninitiated; and never more so than at the beginning of research as in South Arabia, where even the pre-Islamic pottery was virtually unknown.

The temple deposits were singularly poor in potsherds: these were moreover in small fragments, and not a single complete vessel was found. The scarcity also of pottery in the farmstead site suggested that we were dealing with a people, then as now, making and using little earthenware, and relying on skin, wood, and stone for their domestic receptacles. To remedy perhaps these deficiencies, as well as to obtain facts concerning the physical types of these early South Arabians,[3] the discovery of graves was essential. A sedentary Badu in possession of a few ancient beads and a stone incense burner volunteered non-committal information, and Miss Gardner went off to report. It became clear that tombs existed in the lower scree slopes of the northern cliffs, only 1 km. from the temple; indeed our informant lived, comfortably and apparently unsuspectingly, with his family in an anciently robbed one.

The excavation of two in this vicinity [4]—a lengthy affair, as they were large collective sepulchral caves about 8 m. in diameter hollowed out by hand in the sandstone underlying breccia—occupied the remainder of the season, and yielded besides beads and other trinkets a big group of the required pots intact, which will form the essential basis of a South Arabian *corpus*. The skulls are uniformly long-headed. Seals derived from probably Achaemenid

[1] Position is marked A3 on the map, Fig. 2.

[2] Position is marked A4 on the map, Fig. 2.

[3] The generalization has been made that North Arabians are predominantly long-headed, the Southerners round-headed (Hitti, 'History of the Arabs,' p. 30). See also Professor Seligman's remarks (*Geogr. J.* 87, 88 (1931) 34, 239) regarding Mr. Bertram Thomas's anthropometric data from S.E. Arabia.

[4] Marked A5 and A6 on the map, Fig. 2. Further tomb work was sadly abbreviated by a long bout of fever in February.

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172 prototypes give a *terminus a quo* in the sixth to fourth centuries B.C., and suggest the probability of a later local date extending into Roman times.

The jumbled rubble mounds, some 2 m. high, scattered over a wide area of the Hureidha ruin-field, when mapped in detail, fell into orderly lines. They were, in fact, the remnants of an extensive irrigation system which surrounded the pre-Islamic valley sites. The clue to their origin was first found north of A3 and A4. Here in sand-covered ground a parallel line of stones 16–20 m. apart was traced east and west for some distance. Small channels took off from it at an acute angle, always directed eastwards. The broad parallel was clearly a main canal feeding the land on either side. At intervals the stone-covered mounds branched off at right-angles to the main line and to each other, and an examination of their structure quickly showed that they too had been integral parts of the system, placed at nodal points or junctions. The main canal was finally traced continuously for 1200 m. in the immediate neighbourhood of A3, and mapped for more than 3 km. west, or upstream, from that site.

It will be seen from the map, Fig. 2, that the main canal follows the highest ground of the wadi floor and has a fall of 1 m. in 455 m. for the westerly portion. In this part it is ill-defined and marked only by a concentration of pebbles as a 20-m. band along its course. Its nature however is clear from the presence of the minor channels which take off on either side. Just west of A3, near the stone foundations of a house, the line is lost altogether, and is next picked up 250 m. farther north after a fall in level of nearly 2 m. It is probable that erosion has destroyed all traces of this connecting stretch.

From the lower level the main canal runs along a narrow ridge, possibly partly artificial, enclosed by the 792·5 m. contour. It maintains a fairly constant width throughout this stretch of 800 m. and makes two pronounced right-angle bends about half-way along. Just after the most westerly one on the N.–S. leg there is a sudden narrowing to 6 m. for a distance of 10 m., then the full 20-m. width recommences. This probably marks a contrivance for measuring the flow of water. At the eastern end of the 800-m. stretch the 20-m. canal stops, and a pair of 8-m. channels branch off north and south at right-angles. The system then becomes obscured by sand, but it seems to branch into ever narrower channels. Beyond that point no canals were seen, but a settlement or farmstead lies 1 km. beyond the last one mapped and probably was served by the same system. To the south of A3 there is a smooth even slope for 50 m. or more with few or no traces of canals. Then the network begins again. The N.–S. components are the strongest, which is natural, since not only are they the most important but the E.–W. ones would lie right across the drainage line and therefore suffer most from erosion.

It seems probable that the sections of canals now missing were made, as are their modern equivalents, by silt thrown up from the valley floor. Only the important points such as junctions and crossings were stone-built, and these have been left by erosion on isolated mounds, which have themselves been severely reduced.

There seem, then, to have been three types of channels: the main canal which led water from farther afield into the area, and a dependent secondary and tertiary system. The secondary channels are those which took off at right-

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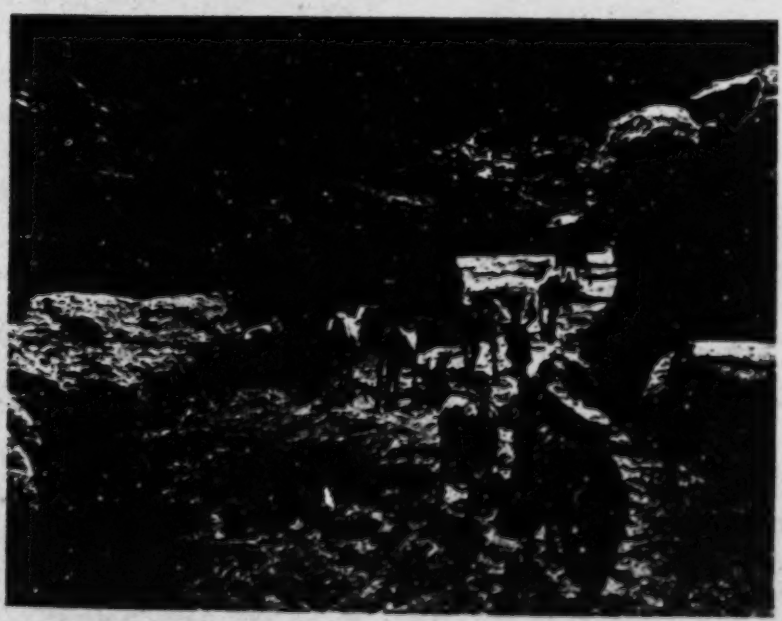
8. Terraces in Wadi 'Amd



9. Wadi 'Amd: tufa boulders in lateral wadi

Facing P 34 (A)

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10. Platform of the Moon God temple near Hureidha

11. Ruin of irrigation dam revetment in Wadi 'Amd

Facing P. 34 (B)

16: Gardner A-4 (1937-38) 1939 MM2 Hadhramaut MM2

172 angles to the main one, and which distributed the water to the field-plots: these are from 4 to 8 m. broad and approximately 2 m. above the general ground-level. The irrigation of the fields themselves was directly controlled by the tertiary system, which consists of short narrow 1-m. ditches, taking off at an acute angle either from the main or secondary channels. The total area covered by this network was about 7 sq. km., and its various parts can be paralleled in the modern irrigation system.

Near the southern edge of this system there are several fields bounded by high silt banks. These are marked on the map by strong dotted lines, and some can be faintly distinguished in Plate 3 on the edge of the valley floor beyond the flood channel. They may be later in date, but in one case a stone inlet and outlet channel was found similar in all respects to the ancient work. The ground-level was here about RL 787 m., the inlet channel at 788·2 m., and the outlet at 787·7 m. Many of these fields have been intermittently cultivated in modern times by means of rainfall only.[1] A scatter of sickle flints and microlithic obsidians was found over the entire irrigated area. It may be noted that obsidian implements were absent on all the Islamic sites examined.

312 [245] 172 At the present day the flood waters are led off the flood channel several kilometres above Hureidha and are carried down by a 4-m. channel running on the south side of the wadi (see Fig. 2) till they reach the palm groves of the town, where they divide and water many thousand palms. As the ancient system was so similar to the modern it seems probable that it resembled it in this respect also. Within the area mapped there was no sign of a supply from the flood channel. The main canal never approached it and the minor ones were actually truncated by it. A day was therefore spent in riding up the wadi in the hopes of finding the take-off of the main pre-Islamic canal. Traces of it were followed for 16 km. but nowhere did it approach the present flood channel till the latter swings across the valley floor towards the north cliffs (Plate 3). Here a well-defined ancient canal is truncated by the wadi bed. It has 2 m. high gravel-covered banks, 30 m. apart, and can be clearly traced for 80 m. or so in an eastward direction. Beyond this point there is no sign of it, and here may therefore be the actual take-off of the flood waters which fed the ancient supply.

Possible confirmatory evidence was obtained about 1 km. upstream. Here there is a remnant of a V-shaped dam which projected from the southern bank part-way across the stream and would have served to divert the current to the entrance of the channel (Plate 11). In the bed itself only the foundations of this dam remain as a band of stones 3½ m. broad, wedged on both sides by larger, more regularly laid material. The downstream arm is 40 m. long and the upstream one 63 m., with a base of 81 m. along the wadi bank. The upstream branch springs from a base that wedges into the gravel of the bank for 2·6 m. The sloping sides are composed of wedge-shaped limestone blocks: eighteen courses high, probably the full number, are preserved on the downstream side and fourteen on the upstream. The infilling is of gravel. No sign of inscriptions or well-dressed stones were seen, and the age must therefore remain conjectural; but local tradition knows nothing of its history.

[1] Mr. Ingrams notes that in the Wadi Maseila the fields are constantly changed—'Hadhramaut' (Colonial Office Report No. 123, 1937, p. 59).

16: Gardner A-4 (1937-38) 1939 MM2 Hadhramaut MM2

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